

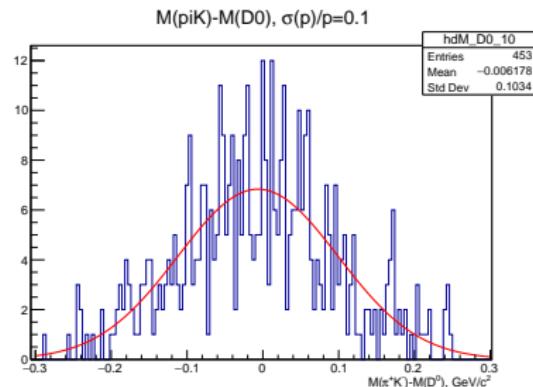
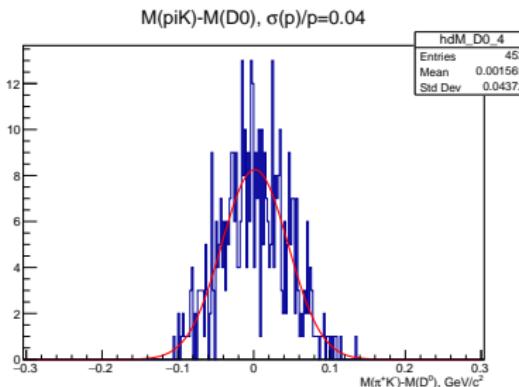
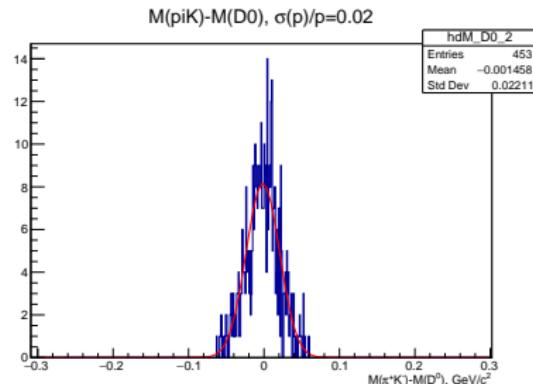
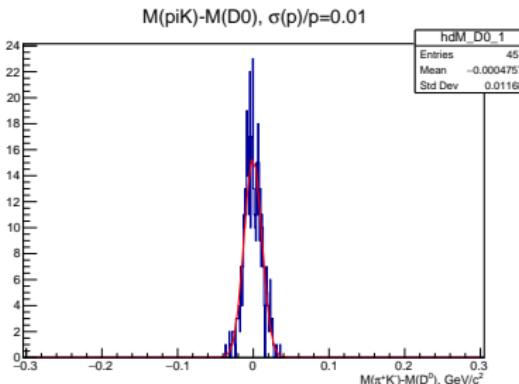
Associated production of D-mesons in pp-collisions at 27 GeV

Mikhail Zhabitsky, JINR

08.09.2021

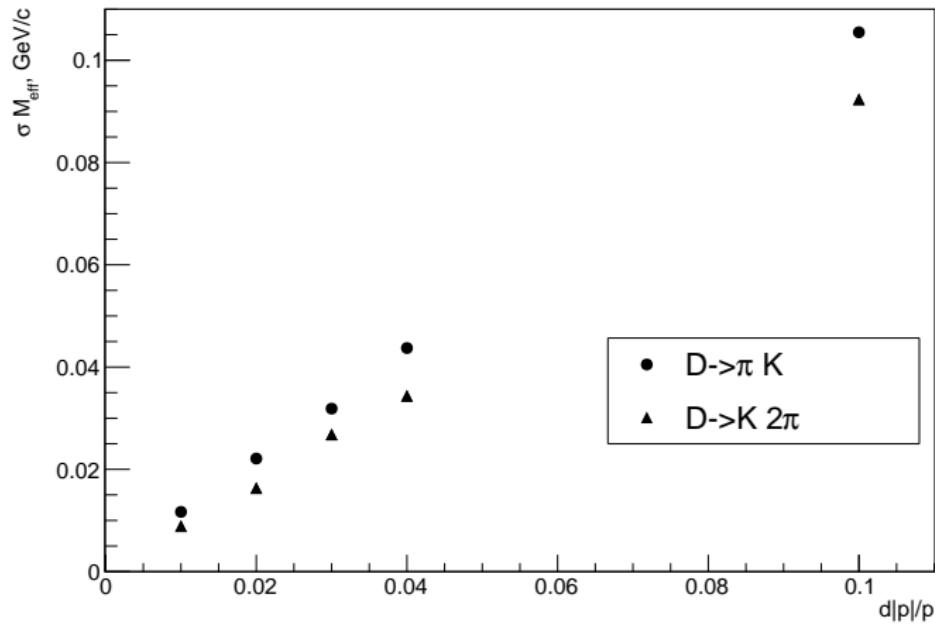
- pythia8.303 ($p + p$, $\sqrt{s} = 27$ GeV, SoftQCD=on)
- Fairly fast: < 1 msec/event
- Channels of interest:
 $D^0 \rightarrow \pi^+ K^- (0.0395 \pm 0.0003)$
 $D^+ \rightarrow K^- \pi^+ \pi^+ (0.094 \pm 0.002)$
- D-meson events tagging:
 1. $D\bar{D}$ -pairs
 2. $D^{*+} \rightarrow D^0 \pi^+$
 3. $\Lambda_c^+ \bar{D}$
- Study is focused on a data-reduction by the online-filter

$D^0 \rightarrow K^- \pi^+$: resolution



100M pp-interactions

$D^0 \rightarrow K^- \pi^+$: resolution

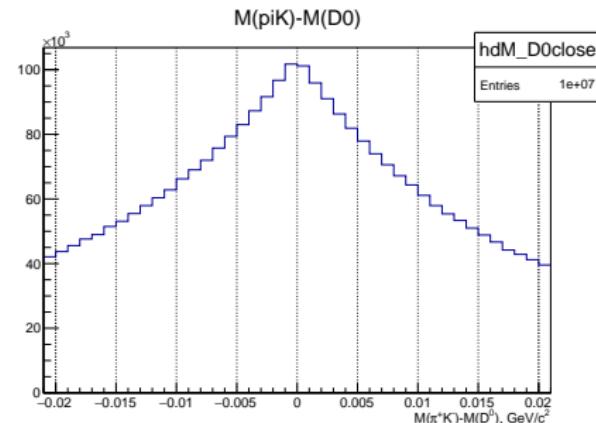
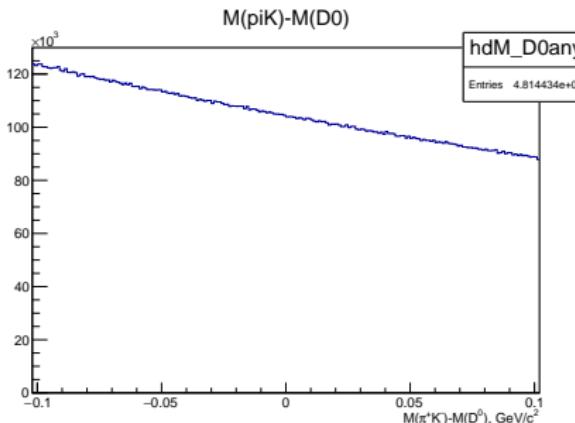


$D^0 \rightarrow K^-\pi^+$: background

Worst-case scenario: only pos/neg charges are distinguished:

Any x^+y^- are treated as π^+K^-

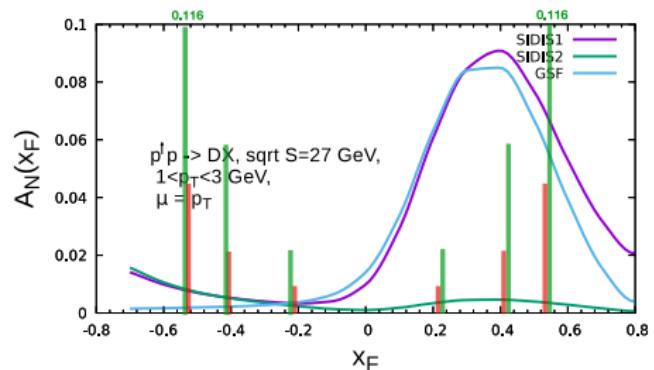
tracks selection: $p > 0.15 \text{ GeV}/c$, $p_T/p > 0.1$



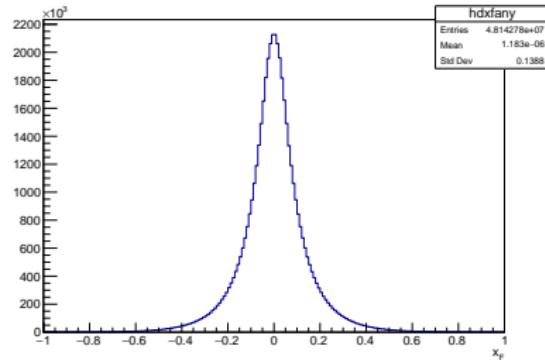
Probability of pos. trigger decision

$\Delta m(D^0 \rightarrow \pi K)$, MeV	$P(\pi^+K^-)$	$P(K^+\pi^-)$	$P(K\pi)$
< 10	0.09	0.10	0.16
< 40	0.27	0.28	0.39
< 100	0.44	0.45	0.52

$D^0 \rightarrow K^- \pi^+$: x_F



Events of interest: $x_F = \frac{p_z}{p_{z,\max}} > 0.2$



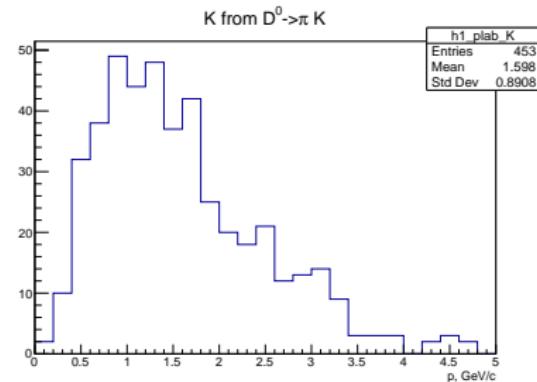
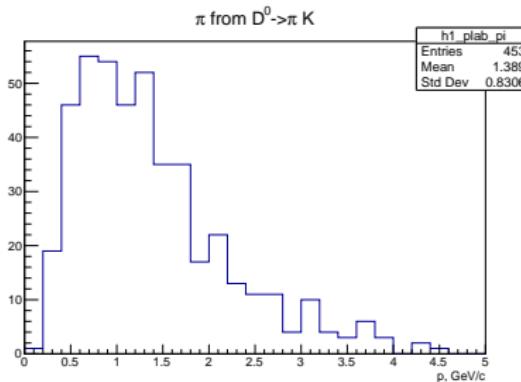
$$D^0 \rightarrow K^- \pi^+ : x_F$$

Events of interest: $x_F = \frac{p_z}{p_{z,\max}} > 0.2$
means $|p_z| > 2.5 \text{ GeV}/c$

Probability of pos. trigger decision (Δm & $|x_F|$)

$\Delta m(D^0 \rightarrow \pi K)$, MeV	$ x_F $	$P(\pi^+ K^-)$	$P(K^+ \pi^-)$	$P(K\pi)$
< 10	any	0.09	0.10	0.16
< 40	any	0.27	0.28	0.39
< 100	any	0.44	0.45	0.52
< 10	> 0.2	0.018	0.021	0.038
< 40	> 0.2	0.07	0.08	0.13
< 100	> 0.2	0.15	0.16	0.24

$D^0 \rightarrow \pi K$: π/K spectra



D-Event-tagging:

Channels of interest:

$$D^0 \rightarrow \pi^+ K^- (0.0395 \pm 0.0003)$$

$$D^+ \rightarrow K^- 2\pi^+ (0.094 \pm 0.002)$$

- $p p \rightarrow D \bar{D} X$: complete reconstruction of D -mesons
- $D^{*+} \rightarrow D^0 \pi^+ (0.677)$
 D^{*+} width: 83.4 ± 1.8 keV
- $p p \rightarrow \Lambda_c^+ \bar{D} X$ with $\Lambda_c^+ \rightarrow p + X (\approx 0.5)$

Rate of charmed events

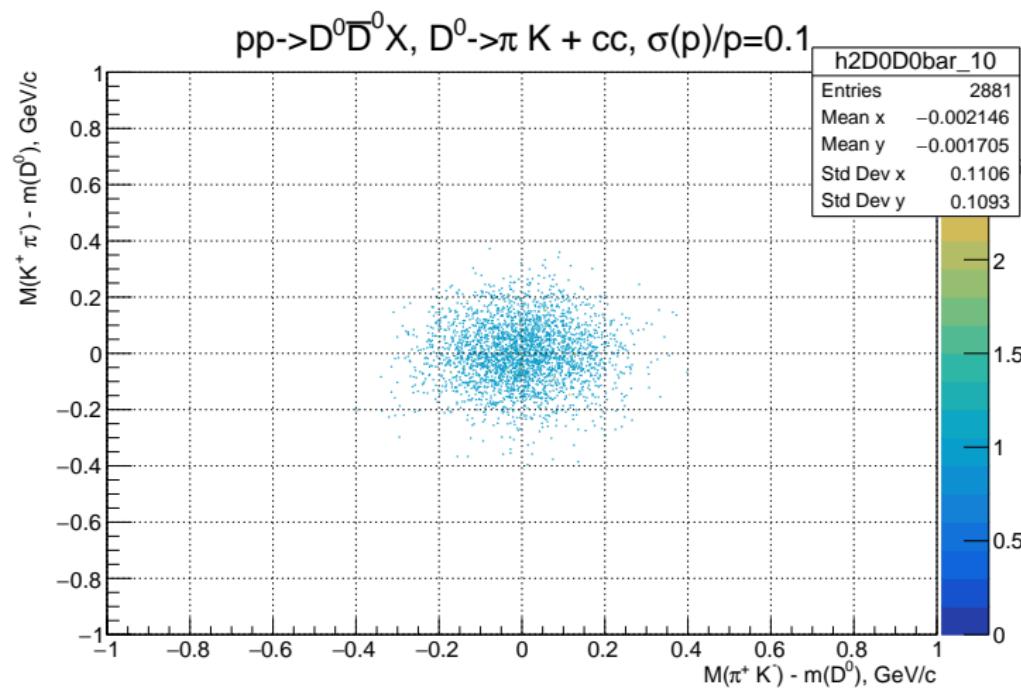
Rate of charmed events per 1M pp -collisions at 27 GeV/ c

D^+X	24.0	$D^{*+}X$	16.7
D^-X	30.8	$D^{*-}X$	19.9
D^0X	48.5	$D^{*0}X$	16.2
\bar{D}^0X	59.2	$\bar{D}^{*0}X$	21.4
D_s^+X	7.2		
D_s^-X	10.4		
Λ_c^+X	22.7		
Λ_c^-X	2.5		

Associated D -meson production:

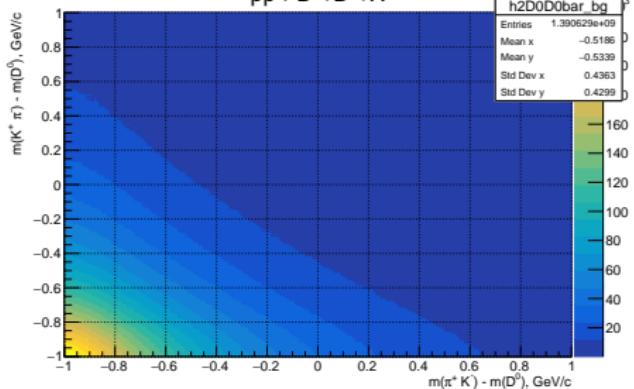
D^+D^-X	8.5		
$D^+\bar{D}^0X$	12.5		
D^0D^-X	14.3	$\Lambda_c^+D^-X$	5.8
$D^0\bar{D}^0X$	29.2	$\Lambda_c^+\bar{D}^0X$	12.6

Note: expected rate of inelastic collisions 3 MHz

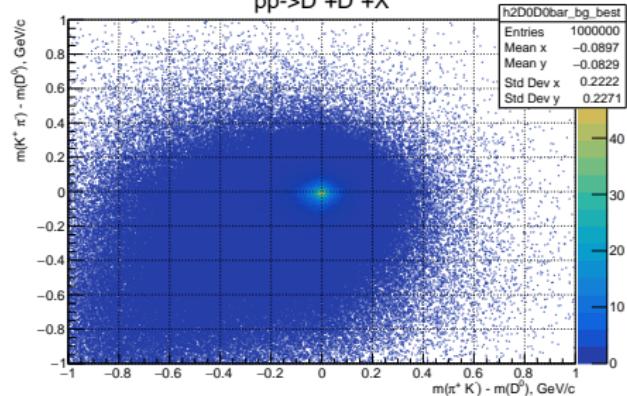


$$pp \rightarrow D^0 \bar{D}^0 X$$

$pp \rightarrow D^0 + \bar{D}^0 + X$



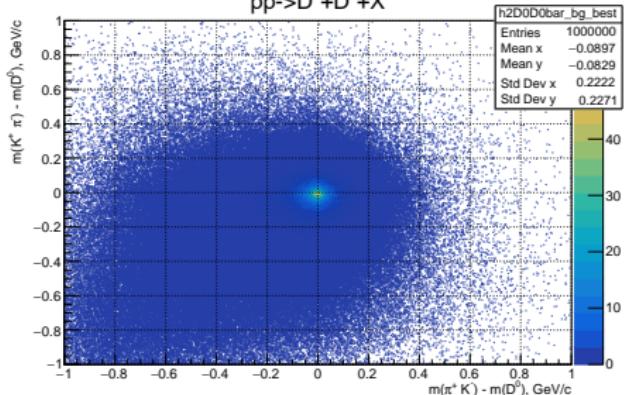
$pp \rightarrow D^0 + \bar{D}^0 + X$



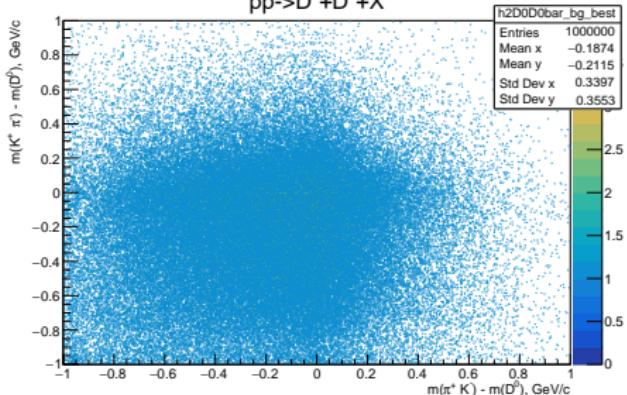
No PID, resolution $\frac{\sigma_p}{p} = 0.1 \Rightarrow 0.32$ — probability to find bg ($\pi^+ K^- \& \pi^- K^+$)

$pp \rightarrow D^0 \bar{D}^0 X$

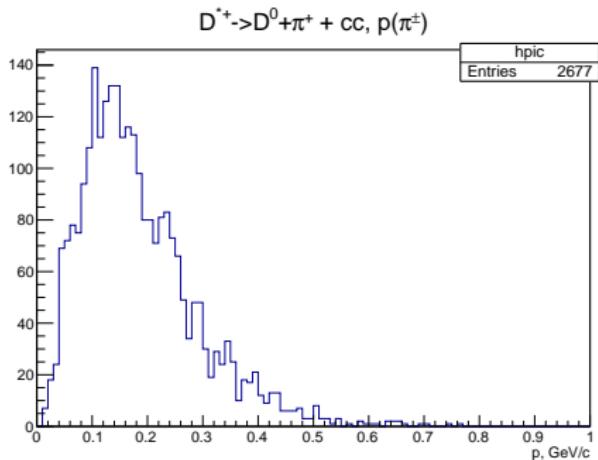
no PID
 $pp \rightarrow D^0 + \bar{D}^0 + X$



ideal PID
 $pp \rightarrow D^0 + \bar{D}^0 + X$



	$\frac{\sigma_p}{p} = 0.1$	$\frac{\sigma_p}{p} = 0.02$
no PID	0.32	0.05
ideal PID	0.01	0.0005



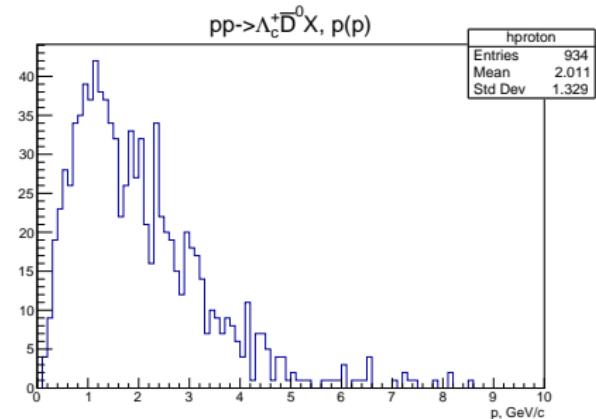
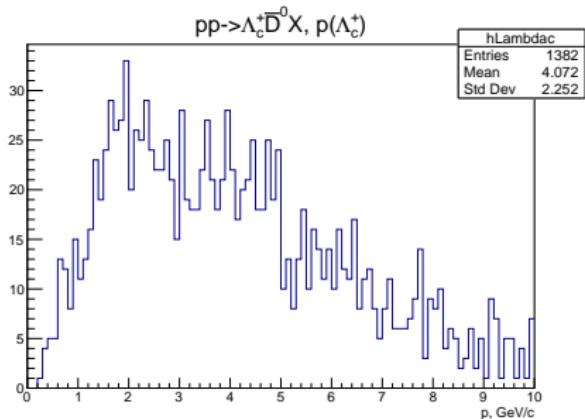
$$D^{*+} \rightarrow D^0 + \pi^+$$

- D^* are abundant
- $\Gamma \sim 0.1$ MeV
- But outgoing charged pion is too soft

$$D^{*0} \rightarrow D^0 + \pi^0 (\text{or } \gamma)?$$

$pp \rightarrow \Lambda_c^+ \bar{D} X$ with $\Lambda_c^+ \rightarrow p + X$

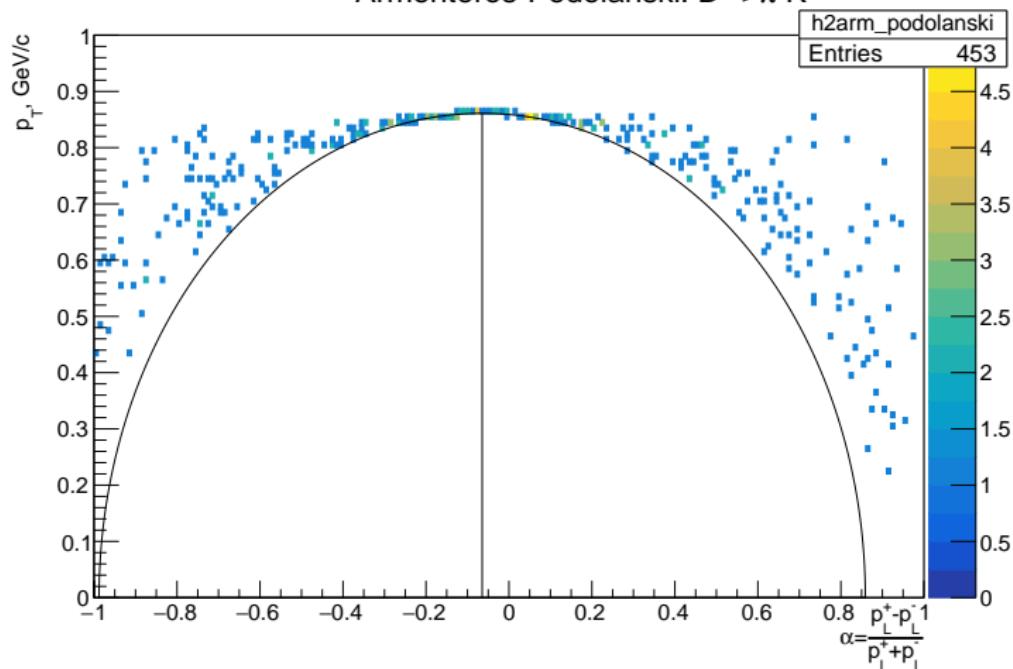
$pp \rightarrow \Lambda_c^+ \bar{D}^0 X$ with $\Lambda_c^+ \rightarrow p + X$ (≈ 0.5)

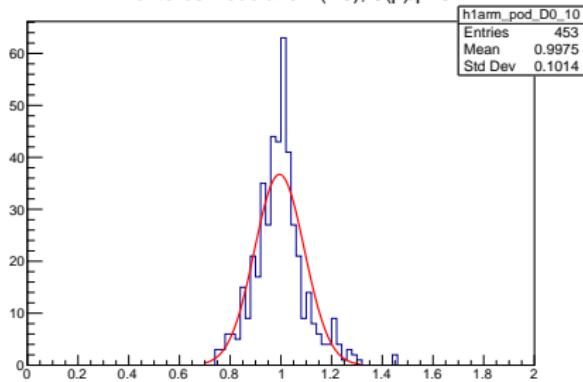


Λ_c^+ are concentrated to the beam axis

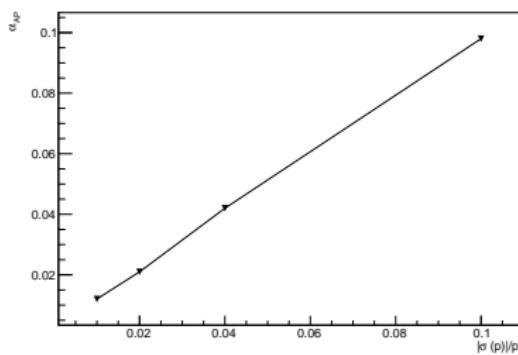
Conclusions

- Momentum reconstruction at online-filtering: resolution?
- Particle identification (π/K)?

Armenteros-Podolanski: $D^0 \rightarrow \pi K$ 

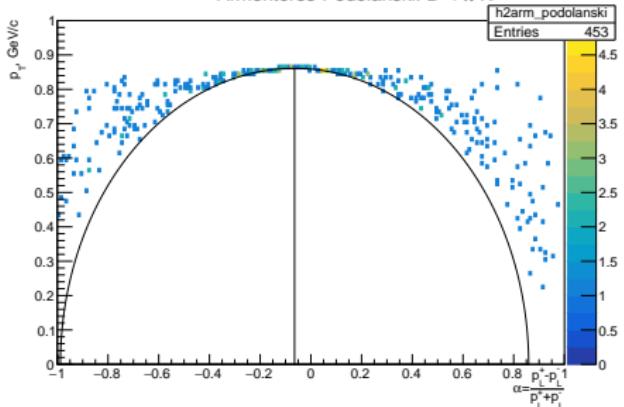
Armenteros-Podolanski (D0), $\sigma(p)/p=0.1$ 

Arm.-Podolanski



$D^0 \rightarrow \pi K$

Armenteros-Podolanski: $D^0 \rightarrow \pi K$



Armenteros-Podolanski: $Bg(\pi, K)$

